LETTERS TO THE EDITOR.

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The Inheritance of Acquired Characters.

SOME years ago I directed attention (*Eugenics Review*, January, 1917, Transactions of the South-Eastern Union of Scientific Societies, 1917) to a remarkable series of experiments by Kammerer, carried out in the Biologische Versuchs-anstalt, Vienna, the results of which were published in a number of papers appearing in the *Archiv für Entwicklungsmechanik*. In these experiments Kammerer subjected a number of species of amphibia and reptiles to the action of a modified environment throughout a period extending from their early youth until the attainment of sexual maturity, and as a result modifications, both of structure and habit, were produced. When these altered individuals were allowed to pair and produce young, these young showed traces of the influences to which their parents had been subjected in two ways, viz. (*a*) when they continued to live in the same environment, the modifications of structure and habit which had appeared in the parents reappeared in *intensified form* in the young; (*b*) when they were transferred back to the original environment proper to the species to which they belonged, they still showed, *in their younger stages of growth*, some degree of the same change in habits and structure as the parents had exhibited.

These results, as I pointed out, would, if confirmed, definitely establish the inheritability of acquired characters, one of the most fundamental questions in biology. But Kammerer's results were received by many of his zoological colleagues, not only here, but also on the Continent, with a storm of criticism. Doubts were cast on his *bona-fides*, and it became fashionable to ignore his results in discussing the laws of heredity. One of the most interesting of Kammerer's experiments had for its subject the "midwife toad" Alytes. This beast differs from other toads, and, indeed, from the Anura in general, in the circumstance that the sexes pair on land, and not, as is the rule among Anura, in the water. In all these water-breeding forms the male is provided with a horny patch situated on the hand below the index finger, in order to enable him to retain his hold of the female when he clasps her under the water. As all know, the eggs are fertilised after being laid, and the young emerge as tadpoles provided with three feathery external gills on each side of the head; but these gills become covered over by the growth of an opercular fold from the hyoid arch and then atrophy, and are functionally replaced by more internally situated gills.

In Alytes the male is devoid of the horny patch on the hand, as the skin of the female, being comparatively dry, is sufficiently adhesive to allow him to retain his hold without it. When the eggs are laid—as is usual amongst toads, in long strings—the male, after fertilising them, winds them round his legs, and thus encumbered he lives in seclusion for several weeks until the young are ready to hatch out. He then visits the water, and the young emerge as advanced tadpoles, in which the external gills have already been covered over. The eggs are fewer in number, much larger in size, and more abundantly provided with yolk than those of other Anura.

Now Kammerer states that if Alytes be kept under conditions of greater warmth than they are normally accustomed to, they will live and flourish if provided with a tank of water in which they can bathe if they feel so inclined. In these circumstances they begin to pair in the water, and the eggs slip off the legs of the male and lie in the water. Most perish, but, by keeping the water aseptic, a few will develop. These, reared to maturity, produce, when sexually ripe, more numerous eggs of smaller size than is normal to the species, and the young hatch out at an earlier stage of development. If we open the egg of a normal Alytes, we discover that the *embryo* is provided with only *one* external gill on each side. Now in this F_1 generation the tadpoles emerge in this stage, and Kammerer figures free-swimming tadpoles of Alytes with one large external gill on each side. When the F_1 tadpoles are reared to maturity, they pair in the water and give rise to tadpoles with *three* external gills on each side, and these tadpoles, reared to maturity, develop into *males with a horny patch* on the finger.

Concerning this experiment, our leading authority on genetics, Prof. Bateson, thus speaks in his latest book ("Problems of Genetics," p. 201):—"To my mind this is the critical observation. If it can be substantiated it would go far to proving Kammerer's case. The figures which Kammerer gives [of the horny patch: E. W. M.] are quite inadequate, and as they merely indicate a dark patch on the thumbs, it is not possible to form any opinion as to the nature of the structure they represent. . . . I wrote to Dr. Kammerer in July, 1910, asking him for the loan of such a specimen, and on visting the Biologische Versuchs-anstalt in September of the same year, I made the same request, but hitherto none have been produced."

Now during the war it has been difficult to obtain German scientific publications, but, through the kind permission of the Board of Trade, we have been enabled to import all the numbers of the *Archiv für Entwicklungsmechanik* published during the war. In the latest of these, published in Berlin early in the present year, there is a paper by Kammerer in which he gives the results of further rearing of Alytes under conditions of greater warmth than normal. His original description of the horny patch on the hand of the male was based on its appearance in males of the F_2 generation, but he describes now males of the F_6 generation, in which the horny patch is so marked that its development exceeds that in the normal male toad (Bufo). He gives photographs of two Alytes males side by side, one of a normal male, one of a modified male, and in this latter the horny wart can clearly be made out. Further, he gives a whole plate of figures of sections through the skin of the hands of normal and modified males, and the last show unequivocally the characteristic horny papillæ which make up the patch.

It must, we think, be conceded that Kammerer has fairly taken up the gauntlet thrown down to him by Prof. Bateson, and the present position of the matter is that a strong *prima-facie* case for the inheritability of acquired variations has been made out. Of course, it is open to those who have attributed fraud to Kammerer to assert that the whole of the evidence adduced in this paper has been manufactured out of whole-cloth, even though the photograph of the modified male is stated to have been taken by an American student in Vienna and not by Kammerer himself. Such doubting Thomases could be convinced only by a journey to Vienna and an inspection of the modified males, for it is unreasonable to expect Kammerer to send these priceless specimens to any zoologist who chooses to doubt his word. It is to be hoped that,

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once peace is signed, this journey will not be delayed. Meanwhile, the average zoologist who reads Kammerer's paper may be pardoned if he feels that the hypothesis of wholesale premeditated fraud is a difficult one to sustain.

It may perhaps be said that no notice should be taken of Kammerer's results until some other investigator repeats them. Such a course is not pursued with regard to any other zoological investigations. When new discoveries are published we thankfully receive them. We keep, perhaps, an open mind until they are repeated, but freely concede that a *prima-facie* case has been made out for them.

To Mendelian critics I would point out that the difficulty of instituting experiments designed to test the inheritability of acquired characters is colossal. Compared with them, the carrying out of experiments in Mendelian inheritance is child's play. With the kind concurrence of Dr. Chalmers Mitchell, I have persuaded Mr. E. Boulenger, Curator of Reptiles, to make preliminary arrangements to have some of Kammerer's experiments repeated in the Zoological Gardens. I found that a minimum of six years would be required before decisive results could be obtained. This new paper of Kammerer's appears to represent the result of seven or eight years' work. The proper rejoinder of the Mendelian is not to gibe at the absence of confirmatory evidence from other investigators (and some even of this is available), but to obey the Scriptural injunction, "Go thou and do likewise."

E. W. MACBRIDE.

Imperial College of Science, May 7.

The Conditions attached to Government Grants for Scientific Research.

MAY I again direct attention to the conditions under which grants are made to individual research workers by the Committee of the Privy Council for Scientific and Industrial Research (London: H.M. Stationery Office, 1919. Price 6*d.*)? The matter is of some importance, as not only are those who refuse to accept these conditions debarred from participating in the grants made from the public purse for scientific research, but other sources which used to be available, and to which such conditions were not attached, are also being cut off. I understand, for example, that the Carnegie Trust for the Universities of Scotland intends very largely in the future to discontinue its grants in aid of research, and to refer applicants to the Government.

By accepting a grant under these conditions, a research worker undertakes not to publish his or her results without the consent of the Committee, and gives up the ownership in the commercial rights of his discoveries, which otherwise, under the Patent law, belong to him. It is the Committee, not the inventor or discoverer, that is to determine to what extent and in what proportion the Committee and those who have made the discoveries are to secure the ownership of the results by patent, presumably on the ground that the Committee has provided the funds for the research. If that is the ground, ought not the Committee to state precisely what is the share it claims, whether the share is limited to the amount of the monetary contribution, or if it intends to make a profit? I understood the money was given by Parliament to foster research, not to exploit it. As it is, a worker accepting a grant places himself absolutely, as regards the legal right to his own property, in the hands of a Committee, and if, as is bound to occur, differences arise as to what is the share of the discoverer or who is the discoverer, the matter is not put into the hands of an impartial arbitrator to settle, but is settled by one of the parties in the dispute. In precisely the same way, with existing secret patents, if a dispute arises between a patentee and the Government, it is the Treasury, who pays for the use of the patent, that settles the dispute.

The condition is justified on three grounds. First, on the ground of national interest, especially in the present abnormal circumstances, and that it is not in the national interest that results of commercial value should be made available to other countries to the detriment of our own. As regards actual war conditions, patents containing any information likely to be of use to the enemy have not been published, so this is secured independently of the question of the ownership of the patent. As regards the future, one is justified in asking whether it is the intention of the Committee that the results of researches obtained by the expenditure of national funds should be kept secret, as most scientific men would regard this as short-sighted.

The second ground is that, where results are to be patented, delay in publication is in the interest of the investigator. This is scarcely relevant. It is surely in the highest degree dangerous to delay applying for a provisional patent until the results have been communicated to the Committee and its consent obtained, for any person who, by lawful or unlawful means, gets the information is then in a position to prevent the real discoverer from protecting himself.

The third ground is that it is the object of the Department to secure to the discoverer a fair share in any profits that may accrue from his discovery. Admittedly, the class of inventors and discoverers is in very great need of being protected from the sharp practices that have sprung up under the shadow of the Patent law, and primarily from the Government itself. But why should a small part of them, who receive Government funds, be singled out and protected? If the discoverer prefers to secure for himself the legal ownership of his discoveries, rather than for the Committee, I do not think he should be debarred from participating in this money. The most, I think the Committee has a right to stipulate is that its interest is limited to the amount it has contributed, and that, in the event of a dispute, the matter shall be referred to an impartial arbitrator for settlement. FREDERICK SODDY.

THE ATLANTIC FLIGHT.

THE attempt to cross the Atlantic by aeroplane, though as yet unsuccessful, has produced one record-breaking long-distance flight. The American seaplane, NC4, has flown from Newfoundland to the Azores, a distance of 1380 miles, thus establishing a record for distance. Trepassey Bay was left on May 16 at 10.05 p.m. G.M.T., and Horta, Island of Fayal, Azores, was reached at 1.23 on the following afternoon, the duration of the flight being 15 hours 18 minutes.

Mr. Harry G. Hawker and Commander Mackenzie Grieve started from St. Johns, Newfoundland, on May 18, at 5.45 G.M.T., for a direct flight to the British Isles, but no news has since been heard of them. It is greatly to be regretted that this daring attempt has failed, and we sincerely hope that the two brave aviators, who flew the Sopwith machine, have been rescued by a passing ship.

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